Afon Tywi SAC shad spawning assessment 2015 (*Alosa alosa & Alosa fallax*), incorporating classification of 2013 and 2014 survey data.

Habitats Directive third reporting cycle 2013 – 2018.

Garrett HM.

NRW Evidence Report No. 87

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Crynodeb Gweithredol

Mae Afon Tywi / River Tywi wedi'i dynodi'n Ardal Cadwraeth Arbennig (ACA) ar sail nifer o nodweddion, gan gynnwys gwangod (*Alosa fallax*) a herlod (*Alosa alosa*). Mae gwangod a herlod yn aelodau ymfudol o deulu'r Clupeidae (teulu'r penwaig) sy'n nofio i fyny afonydd i silio yn hwyr yn y gwanwyn. Ym Mhrydain, mae poblogaethau sylweddol o wangod a herlod yn silio yn afonydd Hafren, Wysg, Gwy a Thywi. Mae poblogaethau'r ddwy rywogaeth dan fygythiad yn Ewrop, yn bennaf oherwydd rhwystrau i'w hymfudiad a phroblemau'n ymwneud ag ansawdd y dŵr.

Mae Cyfoeth Naturiol Cymru (CNC) yn gyfrifol am fonitro cyflwr poblogaethau gwangod a herlod mewn Ardaloedd Cadwraeth Arbennig (ACA) a sicrhau bod eu statws cadwraethol ffafriol yn cael ei gynnal o fewn y safleoedd dynodedig hyn. Cyhoeddodd y Cydbwyllgor Gwarchod Natur (JNCC) ganllawiau cyffredinol ar 'Common Standards Monitoring Guidance for Freshwater Fauna' (JNCC, 2005), sy'n rhoi braslun o'r priodoleddau (gorfodol a dewisol) a'r targedau ar gyfer monitro pysgod dŵr croyw. Mae'r rhain yn cynnwys targedau'n ymwneud â phoblogaethau gwangod a herlod, llif yr afon, ansawdd y dŵr a morffoleg yr afon.

Bu staff CNC yn monitro dosbarthiad y silio ar safleoedd samplu blynyddol o fewn 60 cilometr o goridor y brif afon rhwng 2013 a 2015. Casglwyd tystiolaeth yn ymwneud â silio rhwng 13 Mai a 1 Gorffennaf, yn dibynnu ar y prif amgylchiadau amgylcheddol ar gyfer y flwyddyn honno. Pennwyd enwau is-samplau'r wyau fel rhywogaethau gwangod a herlod trwy ddefnyddio dadansoddiad molecwlar yn 2013 a 2014.

Mae'r targed parthed silio'n nodi y bydd sampl cynrychioliadol o safleoedd yn unedau 5 a 6 yn cael eu monitro bob tair blynedd. Os na fyddant i'w cael yn unedau 5 -6 yn ystod dau arolwg olynol, bydd eu cyflwr yn cael ei asesu fel bod yn anffafriol (Lovering, 2008).

Yn seiliedig ar ddata blynyddol rhwng 2013-2015, mae dosbarthiad silio gwangod a herlod o fewn yr ACA yn cyrraedd ei darged, oherwydd daethpwyd o hyd i wyau ym mhob uned o leiaf unwaith yn ystod y cyfnod samplu teirblynyddol, ac felly caiff targed y dangosydd perfformiad ar gyfer **hyd a lled silio** ei gyrraedd (**Pasio**). Fodd bynnag, dylid adolygu'r Dangosyddion Perfformiad gan nad ydynt yn ategu'n ddigonol y weledigaeth ar gyfer ymfudo.

Argymhellwn y dylai prawf marciwr genetig y rhywogaethau ddod yn rhan o'r fethodoleg fonitro safonol, a bod targed yr asesiad yn cael ei adolygu gan fod mwy o ddata wedi'i gasglu a chan fod ein dealltwriaeth o ymddygiad gwangod a herlod Afon Tywi wedi gwella ers i'r cynllun rheoli craidd gael ei gyhoeddi yn 2008 (Lovering).

Bydd yr asesiad cyffredinol o nodweddion herlod a gwangod, sef "Ffafriol" neu "Anffafriol", yn cael ei gwblhau ar ôl i ddigon o ddata gael ei ddadansoddi ar gyfer ansawdd y dŵr, llif yr afon a morffoleg yr afon.

Testun cryno ar gyfer 'trydar' ar gyfrif Twitter CNC

Haf 2015 tymor o gariad i wangod a herlod – cofnodi silio 22km i fyny'r afon wrth bont Cilsan, Afon Tywi, Sir Gâr, @ allis twaite shad

Executive summary

The Afon Tywi / River Tywi is designated as a Special Area of Conservation (SAC) for several features including twaite shad (*Alosa fallax*) and allis shad (*Alosa alosa*). Shads are migratory members of the Clupeidae (herring family) that ascend rivers to spawn in late spring. In Britain, significant populations of shad spawn in the Rivers Severn, Usk, Wye and Tywi. The populations of both species are threatened in Europe mainly due to obstructions to migration and issues surrounding water quality.

Natural Resources Wales (NRW) is responsible for monitoring the condition of shad populations within SACs and to ensure the maintenance of favourable conservation status within these designated sites. The Joint Nature Conservation Committee (JNCC) published generic guidance on 'Common Standards Monitoring Guidance for Freshwater Fauna' (JNCC, 2005) outlining the attributes (mandatory and discretionary) and targets for monitoring freshwater fish. These include targets for shad population, river flow, water quality and river morphology.

NRW staff monitored the spawning distribution at annual sample sites within 60km of the main river corridor between 2013 and 2015. Evidence of spawning was collected between13th May and 1 July, depending on the environmental conditions prevailing in that year. The identity of sub-samples of the eggs as shad species was determined using molecular analysis in 2013 and 2014.

The spawning attribute target states that a representative sample of sites within units 5 to 6 will be monitored at 3 yearly intervals. Absence from within units (reaches) five to six in two consecutive surveys will result in an unfavourable condition assessment (Lovering, 2008).

Based upon the annual data from between 2013 - 2015 the spawning distribution of shad within the SAC meets its target because eggs were present in each unit at least once during the triennial sampling period and so the performance indicator attribute target for **spawning extent** is met (**Pass**), however, the Performance Indicators should be reviewed because they do not adequately underpin the vision for migration.

We recommend that the species genetic marker assay should become part of the standard monitoring methodology and that the assessment target is reviewed now that more data has been collected and our understanding of Tywi shad behaviour has increased since the core management plan was published in 2008 (Lovering).

The overall assessment of the allis and twaite shad features as either "Favourable" or "Unfavourable" will be completed after sufficient data has been analysed for water quality, river flow and morphology.

Summary text for English tweet on NRW Twitter account

2015 Summer of love for shad fish species as spawning recorded 22km upstream at Cilsan bridge River Tywi, Carms, @ allis twaite shad

1. Introduction

This annual report analysing the spawning distribution of allis shad (*Alosa alosa*) and twaite shad (*Alosa fallax*) on the Afon Tywi SAC should be read in conjunction with the Tywi shad egg survey report for 2013 and 2014 (Garrett et *al.*, 2014). This previous report should be consulted for the following information which also relates to the 2015 spawning condition assessment:

- Distribution of shad species in Wales
- Conservation status of allis and twaite shad in Wales under the European Habitat Directive.
- Condition assessment and monitoring of shad species on the Afon Tywi SAC using targets from the Common Standards Monitoring (CSM) guidance.
- Quality assurance of egg sampling by using molecular analysis on the Afon Tywi SAC.
- Details of standard NRW methodologies for field survey & data analysis.

2. Objectives

The aim of this interim report is to contribute to the assessment the condition of the shad population in the Afon Tywi SAC based on 2015 egg surveys. The objectives of this study are to;

- Conduct a shad egg survey on the Afon Tywi in 2015.
- Analyse and present the results for spawning distribution of the population attribute only for the 2013, 2014 and 2015 data.

4. Methods

4.1 Sampling methodology

In general, the kick sampling method described in Hillman *et al*. (2003) was followed but with modifications; the Hillman methodology was modified to a minimum of 10 kick samples were undertaken at each site with the number of eggs found in each kick recorded. A standard macroinvertebrate hand net (250µm) was used to collect material dislodged by kicking (or 'shuffling') upstream of the net for approximately 15 seconds. The net was checked for the presence of shad eggs after each kicking interval and any detritus or channel substrate removed before kicking was resumed. The number of shad eggs were counted after each kick sample and recorded on the field sheet. Sampling started at the downstream end of the potential spawning site to prevent the possible re-recording of eggs dislodged in previous kicks. If possible, sites where no eggs were found were re-visited at a later date in the spawning season, however, this was dependant on weather conditions and availability of the survey team. For more details of the sampling methodology see Garrett et *al.*, 2014.

In previous surveys eggs have been sent for molecular analysis to verify the identity of the eggs using genetic markers, however, no eggs were sent for analysis in 2015.

4.2 NRW shad egg survey 2015

Fourteen sites were surveyed between 13th May and 5th June over a period of seven days by a team of three surveyors (Figure 1). The survey teams were drawn

from a pool of 17 trained people from NRW South West Wales Operations Team and on average each team comprised three people.

The surveyors undertook this survey using protected species licence number 55303:OTH:SA:2014 which is valid until 31st July 2016. Details of the survey data archive are shown in Appendix 2.

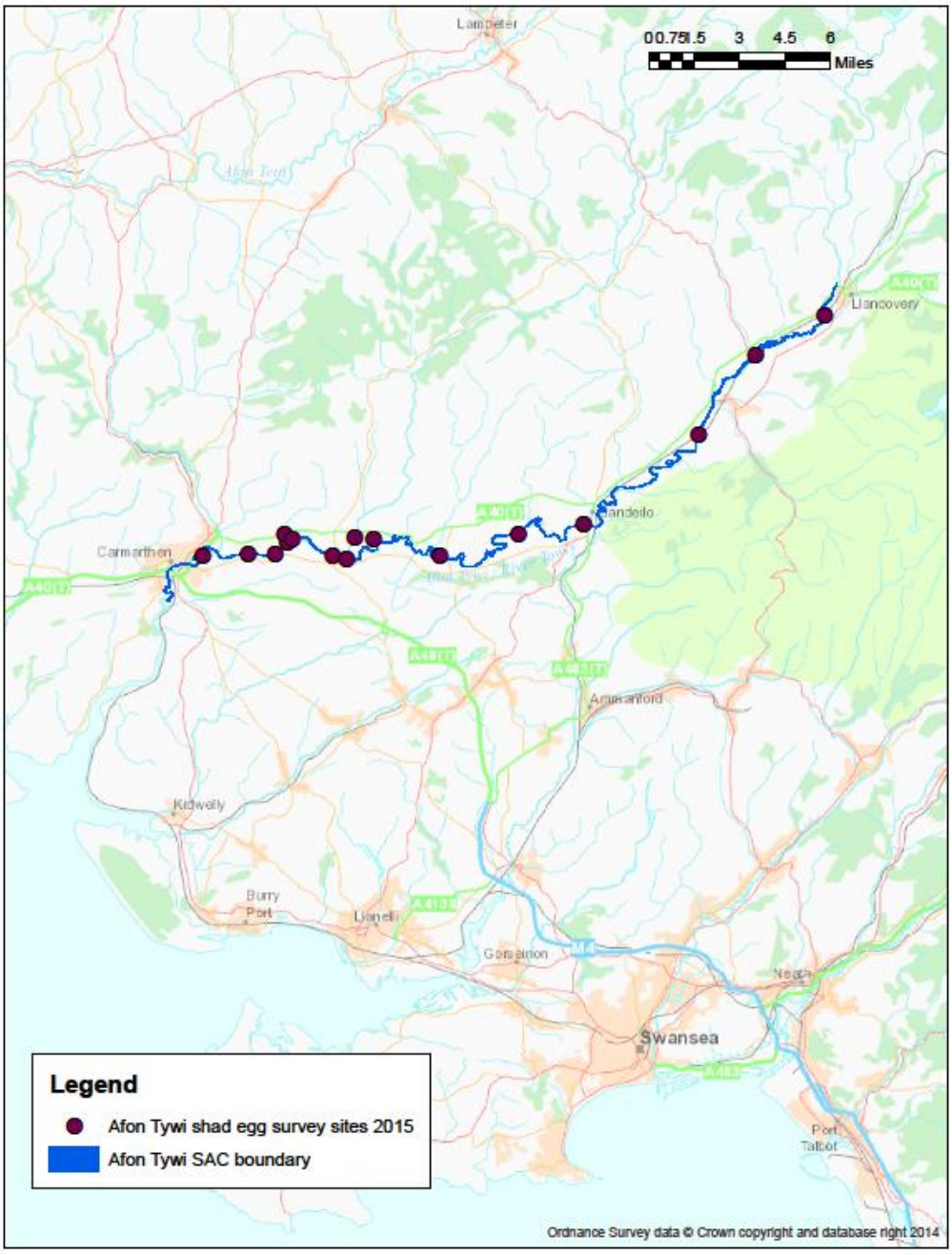

Figure 1: Location of 2015 shad egg survey sites

4.3 Recording variation in river flows for spring 2015

The monthly mean and minimum flows for May and June at four flow gauging station (FGS) on the Afon Tywi are shown in the data was collected and analysed by NRW South West Hydrometry & Telemetry Team.

Synoptic metrological information was taken from the MetOffice website for the spawning period to give context to the water temperature and flow data for the Tywi.

4.4 Barriers to migration

Structural barriers to migration were assessed by checking:

- the barriers previously mentioned in shad egg surveys
- the NRW ArcGIS “River obstructions” dataset (dating from 2010).

The NRW South West Operational Team members were consulted for their views on the resulting list of barriers

4.5 Condition assessment targets

The spawning distribution was assessed using egg survey data collected by the NRW SW Operational team between May 2013 and June 2015. The results for the 2013 and 2014 surveys are presented in an earlier report (Garrett & Thomas, 2014). At the time of publication the analysis did not include an assessment against the target because it was anticipated that the CCW management units would shortly be harmonised with WFD waterbodies but to date the revised units have not been confirmed. (The EA drew up boundaries for rivers called “water bodies” based on the natural characteristics of the river. The water body is the unit for which environmental objectives are set under the water Framework Directive (WFD) (EA, 2012)). It has been decided to assess the spawning distribution using the data from 2013 - 2015 against the target as defined in the current core management plan which is based on the CCW units. If the units and management plan are amended before the close of the third reporting cycle than an assessment using the revised target and units will be undertaken.

5. Results

5.1 Frequency of sampling at sites and presence / absence of eggs

Nine sites (64%) were visited twice in the season and one site was sampled three times (Llandeilo Bridge, 10). At Glantowylan (3 & 2b) and Nantgaredig bridge (5) eggs were recorded on both occasions. Eggs were absent at four sites on both visits (6, 8, 11 & 12). Eggs were recorded at three sites on the initial visit but not in the subsequent one (4a, 9 & 16). For the latter three sites the gap between the visits ranged from 7 – 9 days. At Llandeilo Bridge (10) no eggs were recorded on any of the three site visits which were conducted between 19 May – 5 June (26 days) (Table 1 & Figure 2).

Site No.	Site name	NGR	Dates surveyed 2015	Shad eggs present or absent
16	Tidal limit	SN4480020400	13-May	**Present**
	Tidal limit is the most downstream survey site		20-May	Absent
1	Llangunnor	SN4240020300	*Not surveyed*	*Not surveyed*
2 (& 2a)	Penddaulwyn	SN4623120402	13-May	**Present**
3 (& 2b)	Glantowylan	SN4690021000	13-May 13-May	**Present (2b)** **Present (3)**
4	White Mill	SN4674021494	13-May	**Present**
4a	Habitat 8	SN4714621161	13-May 21-May	**Present** Absent
5	Nantgaredig Bridge	SN4930020300	14-May 27-May	**Present** **Present**
6	Cothie confluence	SN5003820096	14-May 27-May	Absent Absent
6a	Cothie Bridge	SN5050421250	27-May	Absent
7	Llanegwad	SN5150021200	*Not surveyed*	*Not surveyed*
8	Dryslwyn	SN5503120345	19-May 28-May	Absent Absent
9	Cilsan Bridge	SN5916821463	19-May 28-May	**Present** Absent
10	Llandeilo Bridge	SN6265321991	19-May 28-May 05-Jun	Absent Absent Absent
11	Manordeilo	SN6875926802	20-May 05-Jun	Absent Absent
12	Llanwrda	SN4480020400	19-May 28-May	Absent Absent
13	Llwynjack	SN7548833138	20-May	Absent
			20-May	Absent

Table 1: Results of shad egg survey Afon Tywi SAC 2015

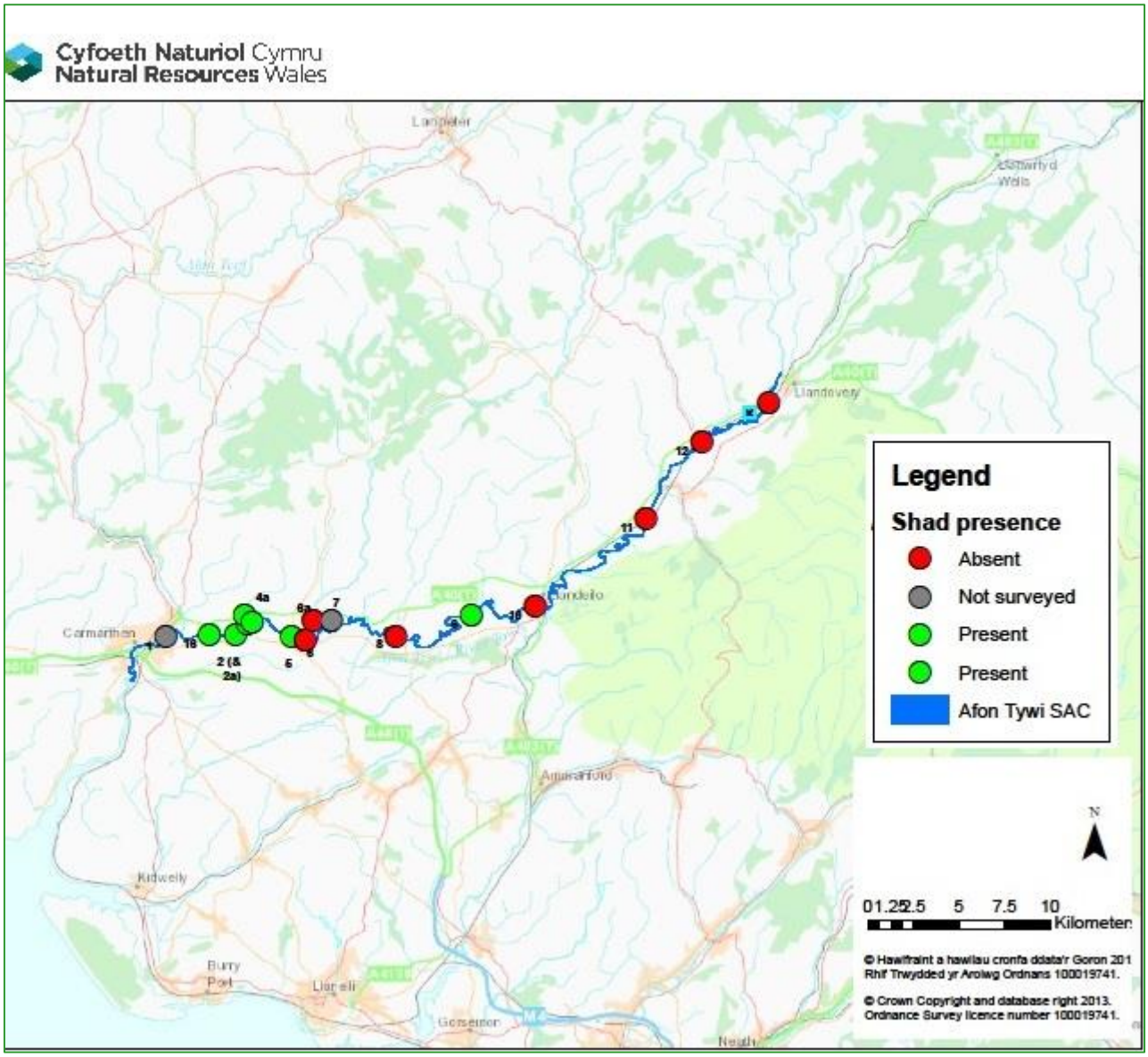

Figure 2: Map showing extent of shad spawning in 2015.

Figure 2 shows that spawning shad were not detected above Golden Grove reach (site 10) which is in the mid catchment of the main Afon Tywi corridor.

5.3 Abundance

A total of 288 eggs were collected at eight sites which acts as a coarse indicator of abundance. The most eggs (117) were found at the lowest site in the catchment (Tidal limit, 16). The fewest were found at Whitemill (10 eggs) which is mid catchment and 18km downstream of the spawning limit recorded in 2015 (Table 2).

Site code	Site name	NGR	CCW SAC unit	WFD WB unit	Total eggs
16	Tidal Limit	SN4480020400	6	GB110060029290	**117**
1	Llangunnor	SN4240020300	7	GB110060029590	0
2 & 2a	Penddaulwyn	SN4623120402	6	GB110060029290	**39**
3 & 2b	Glantowylan	SN4690021000	6	GB110060029290	**65**
4	Whitemill	SN4674021494	6	GB110060029290	**10**
4a	Habitat 8	SN4714621161	6	GB110060029290	**12**
5	Nantgaredig	SN4930020300	5	GB110060029590	**33**
6	Cothi Confluence	SN5003820096	5	GB110060029290	0
6a	Cothi bridge	SN5050421250	5	GB110060029290	0
7	Llanegwad	SN5150021200	5	GB110060036350	0
8	Dryslwyn	SN5503120345	5	GB110060036250	0
9	Cilsan Bridge	SN5916821463	4	GB110060036250	**11**
10	Llandeilo Bridge	SN6265321991	4	GB110060036250	0
11	Manordeilo	SN6875926802	3	GB110060036250	0
12	Llanwrda	SN7180931006	2	GB110060036250	0
13	Lwynjack	SN7548833138	1	GB110060036350	0

Table 2: Total no. eggs recorded at each survey site

5.3.3 Extent and limits of spawning

In 2013 the upper limit of spawning was noted at site 11 (Llandeilo reach), but by contrast in 2014, spawning was limited to much lower in the catchment between sites 16 and 5. (Site 5 is just within the lower boundary of Half Way reach). This context shows that the spawning range for 2015 is mid-way between the extent of spawning detected in the previous two years.

5.5 Weather patterns and temperatures during 2015

After a showery start, with strong winds on several days, the May weather did improve slightly but it was generally an unsettled and cool month throughout, with only a few fine days. The mean temperature for the month was 0.8 °C below average, with maximum temperatures also below average, but with minima very near normal. Rainfall was above average for Wales overall (MetOffice, 2015a).

June had an unsettled start, with rain or showers and strong winds, the weather settled down for a time. After another cooler spell with some rain or showers, the end of the month was sunny and very warm. The mean temperature was 0.2 °C below average and rainfall was broadly below normal for Wales (MetOffice, 2015b).

During the spawning run the air temperature was generally cooler with above average rainfall during May but below average in early June.

5.6 Afon Tywi water temperature readings 2015

During this shad egg survey, temperature recordings were made more consistently than in the second cycle of reporting (2007 – 2012). In the 2015 survey the mean was 13.0 ˚C (*n* = 25). The readings ranged from 10.0 ˚C – 16.5 ˚C. The lowest temperature was recorded on 20th May at Llwynjack (site 13), the highest temperature was recorded seven days later at Nantgaredig bridge (site 5).

Frequent temperature recordings are not usually collected by NRW but the Tywi had an extended network of temperature probes from between 2005 – 2012 in response to on-going case work (Carpenter & Tudor-Ward, 2012).

5.7 Monthly flow patterns in May & June on the Afon Tywi 2015

The average of the May and June 2015 mean monthly minimum flows was calculated for each FGS and compared with the average for the same months in the previous decade (long term mean for 2000 – 2014) (Table 3). The mean minimum flows at every station in 2015 was less than the long term means for 2000 – 2014. The greatest decreases were recorded at Capel Dewi and Ystradffin FGS.

The pattern of the minimum mean flows for each FGS remained similar over the 15 year period.

Mean minimum flow m^3/s	Capel Dewi	Manorafon	Dolau Hirion	Ystradffin
May – June 2015	19.55	11.70	6.17	2.60
May - June 2000 - 2014	21.27	12.70	6.25	2.87
% decrease in 2015	8.10%	7.87%	1.25%	9.55%

Table 3: Comparison of mean minimum flow for 2015 with long term minimum mean for 2000 – 2014.

5.8 Additional fish species

Fish species “by-catch” is also recorded by the surveyors and a summary is shown in Figure 4.

Non-target fish species	2015 sites
Bullhead	5, 6, 6a, 8, 11, 12, 13
Lamprey species	4, 10
Lamprey, sea	4a (dead)
Eels	5, 6, 6a, 8, 10, 12
Minnow	5, 9
Trout	4, 10
Stone loach	3, 6, 10, 12

Table 4: Non-target fish species recorded in 2015 survey

Bullhead and lamprey are a designated SAC species for the Tywi and the juvenile fish are often dislodged from under cobbles by kick sampling. Bullhead were found throughout the catchment as were eels. Juvenile bullhead are relatively small and so the kick sampling technique is more likely to dislodge them from under large cobbles and small boulders. The Afon Tywi is also designated as a SAC for all three native lamprey species so confirmation of their presence is welcome. The sea lamprey record is valuable for confirming spawning activity (It is assumed that the animal was spent after spawning).

5.8 Barriers to migration

It was concluded that the old creamery weir, Llangadog and the blockstone weir, Manorafon are no longer considered to be barriers to shad migration. The NRW South West Operational team were not aware of the artificial weir at Llandeilo bridge (listed in the GIS dataset as Obstructid17026) and do not consider it an issue (Paul Hyatt, *Pers comm*, 2015).

There is no attribute target for barriers to migration in the core management plan (Lovering, 2008) so this attribute cannot be assessed.

5.9 Spawning distribution assessment

Spawning distribution target

The spawning attribute target states that a representative sample of sites within units 5 to 6 will be monitored at 3 yearly intervals. Absence from within units (reaches) five to six in two consecutive surveys will result in an unfavourable condition assessment (Lovering, 2008).

5.9.1 Spawning distribution and WFD waterbodies

There are six water bodies within the Afon Tywi SAC boundary and all were surveyed for shad eggs between 2013 and 2015. Shad eggs were present in three of the water bodies (50%) but absent from GB110060036300, GB110060036330 and GB110060036350 (this water body extends beyond the boundary of the SAC). The latter two water bodies are in the upper catchment of the Tywi and GB110060036300 is mid-catchment.

FD Waterbody No. (In increasing distance from tidal limit)	Site Name	Site code	Shad Present / Absent		
			2013	2014	2015
GB110060029590	Llangunnor	1	Not surveyed	Not surveyed	Not surveyed
	Tidal limit	16	Present	Present	Present
GB110060029290	Penddaulwyn	2	Not surveyed	Present	Present
	White Mill	4	Present	Present	Present
	Habitat 8	4a	Not surveyed	Present	Present
	Cothi confluence	6	Present	Present	Present
	Nantgaredig Bridge	5	Present?	Present	Present
	Glantowylan	3	Absent	Present	Present
GB110060036300	Cothi Bridge	6a	Absent	Absent	Absent
GB110060036250	Cilsan Bridge	9	Present	Absent	Present
	Llandeilo Bridge	10	Present	Present?	Absent
	Manordeilo	11	Present	Absent	Absent
	Llanegwad	7	Absent	Not surveyed	Not surveyed
	Dryslwyn	8	Absent	Absent	Absent
GB110060036330	Llanwrda	12	Not surveyed	Absent	Absent
GB110060036350	Lwynjack	13	Absent	Absent	Absent
	Llandovery (not in SAC)	14	Not surveyed	Not surveyed	Not surveyed
	Dolauhirion (not in SAC)	15	Absent	Not surveyed	Not surveyed

Table 5: Presence of shad eggs in WFD water bodies of Afon Tywi 2013 – 2015

5.9.2 Spawning distribution and CCW management units

CCW Unit No.	Unique unit no.	CCW Unit name (in increasing distance from tidal limit)	Site name	Site code	2013	2014	2015	Overall	Confidence
6	737	Whitemill Reach	Penddaulwyn	2	✓ (2/3)	✓ (12/12)	✓ (6/8)	**Pass**	High
			Glantowylan	3					
			White Mill	4					
			Habitat 8	4a					
			Tidal limit	16					
7	734	Carmarthen Reach	Llangunnor	1	NS	NS	NS	Not assessed	
5	738	Halfway Reach	Nantgaredig Bridge	5	✓ (1/5)*	✓ (6/11)	✓ (2/7)	**Pass**	High
			Cothi confluence	6					
			Cothi Bridge	6a					
			Llanegwad	7					
			Dryslwyn	8					
4	739	Golden Grove Reach	Cilsan Bridge	9	✓ (2/2)	**?** (1/4)	✓ (1/4)	**Pass**	Med
			Llandeilo Bridge	10					
3	740	Llandeilo Reach	Manordeilo	11	✓ (1/1)	**X** (0/2)	**X** (0/2)	Fail	High
2	741	Llangadog Reach	Llanwrda	12	NS	**X** (0/2)	**X** (0/2)	Fail	High
1	742	Llandovery Reach	Llwynjack	13	**X** (0/1)	NS	**X** (0/1)	Fail	High

Table 6: Presence of shad eggs in CCW management units Afon Tywi 2013 – 2015.

Table 6: Figures in brackets represent the number of sites where shad eggs were present followed by the total number of sites surveyed in that unit. NS indicates not surveyed. The assessment target units are highlighted in blue. The confidence level relates to the quality of data for the unit

Units 5 and 6 (highlighted in blue in table 3) are the key units for the spawning assessment target and they meet the threshold with high confidence. Unit 4 also meets the criteria with medium confidence due to the small sample size. Three units failed to meet the target; these were upstream of Llandeilo and are all in the higher reaches of the catchment. The unit lowest in the catchment (Unit 7) was not assessed.

[1] Nantgaredig bridge eggs were confirmed by genetic analysis as minnow (*Phoxinus phoxinus).*

The most upstream record of shad eggs was in Golden Grove reach at Llandeilo bridge This is broadly similar to the upstream limit of spawning in previous years (Garrett, *et al.,* 2012;), however, the most upstream record of spawning that was also confirmed by molecular analysis was at the Cothi confluence (site 6a) in 2013 (Hardouin *et al.,* 2013).

Between 2013 and 2015 the extent of egg deposition **passed the spawning distribution** criteria.

6. Discussion

6.1 Sampling methods

Using in-house resources to undertake this survey work continues to be an efficient use of resources on the Afon Tywi, although no funding was available to quality assure the identification of shad eggs by using molecular analysis techniques in 2015. However, previous quality assurance has shown very high levels of correct identification with c. 90% correct in 2013 and 100% correctly identified in 2014 (Hardouin,*et al.,* 2013; Stone, 2014).

A full discussion of the sampling methodology is available in Garrett *et al* (2014).

6.2 Timing of spawning

The upstream migration of shad appears to be triggered by water temperature which on the Tywi is approximately 14 °C (Maitland & Hatton-Ellis, 2003). Based on this evidence the CSM guidance (JNCC, 2005) suggests that the optimum time for sampling shad eggs is between May and June. However, timing the survey to coincide with the maximum abundance of eggs is quite difficult due to inter-annual variability in weather patterns and the sometimes fast changing environmental conditions in the river. This spring weather variation is illustrated in Table 8.

Survey year	Survey dates	Comments
2013	11 June – 1 July	May & June were wetter and slightly cooler than average, so higher river flows in May delayed the survey.
2014	16 May – 11 June	May was warmer and wetter than average but June rainfall and air temperatures were below average.
2015	13 May – 6 June	During the spawning period the air temperature was generally cooler with above average rainfall during May but below average in early June.

Table 7: Synopsis of spring weather 2013 - 2015

6.3 Extent of spawning

The spawning target was set using limited historical evidence collated by Noble *et al* (2007). They found that in the majority of years shad spawned below White Mill, near Carmarthen, however, more recent evidence suggests that Llandeilo is the natural limit of spawning.

The spawning range may also increase as a result of the climate leading to an increase in the river temperature (Knights, 2013).

The additional evidence should be used to regularly review the spawning target relating to the population performance indicators (Table 8).

Population attribute	Target	Assessment	Comments
Adult run size	Adult run size should comply with an agreed target for each river. No drop in the annual run size greater than would be expected from variations in natural mortality alone.	Fish counters inc. DIDSON	The use of hydroacoustic counters for estimating run size is currently being investigated by NRW
Spawning distribution	The spawning attribute target states that a representative sample of sites within units 5 to 6 will be monitored at 3 yearly intervals. Absence from within units (reaches) five to six in two consecutive surveys will result in an unfavourable condition assessment.	Kick sampling during May and June	Where there are man-made barriers to migration, the site should automatically be classed as unfavourable

Table 8:: Common Standards Monitoring guidance attribute targets have been incorporated into the Afon Tywi core management plan (JNCC, 2005; Lovering, 2008)

6.4 Barriers to migration

There is no target in the CCW core management plan for barriers to migration although it is a discretionary attribute in the CSM guidance (2005). Artificial structures that were of concern in the previous reporting cycles are no longer considered to be an effective barrier to shad migration (Hyatt, *pers comm,* 2015).

The CSM target for river morphology is “No artificial barriers significantly impairing adults from reaching existing and historical spawning grounds”.

A target similar to this should be added to the SAC management plan in order to allow for the risk of barrier construction or modification’. However, at present the river would pass such a target.

6.6 Implications for future monitoring

Kick sampling for shad egg should continue to be conducted on an annual basis on the Afon Tywi by NRW staff at the current sampling sites. A minimum of twelve sites per year should be sampled with two sites monitored in each CCW unit and WFD water body. This spatial strategy could be reviewed after the units have been harmonised into one NRW system which is primarily based on the WFD water body boundaries.

Survey effort should prioritise the most upstream units near Llandeilo because the marginal sites are more sensitive to changes. Water temperature is an important physical factor affecting the migration and recruitment of the shad populations. Carpenter & Tudor-Ward recommend that the air and water temperature recording is continued on the Tywi and that similar network of sampling points is set up on the Usk and Wye to generate data for comparison (the rivers Usk and Wye are also designated as SACs for both shad species).

Kick sampling is a cost effective method for assessing spawning but it is not possible to visually distinguish the two species at the egg stage. This taxonomic uncertainty can be reduced if genetic markers are used to determine that the eggs belong to the shad family (Hardouin *et al.,* 2013; Stone 2014). This approach would increase our confidence in our assessments and develop our understanding of the status of shad in Wales.

7.0 Conclusion & recommendations

7.1 Conclusions

The **extent of spawning** by shad species in the Afon Tywi **met the target** between 2013 and 2015 (**Pass**).

7.2 Recommendations

The spawning target should be regularly reviewed in the light of more evidence and they should be incorporated into the revised core SAC management plan and the NRW monitoring and evidence strategy for these two species as soon as possible.

Prior to 2014 survey sites were usually only sampled once during the spawning season, however, in 2014 the majority of sites received repeat visits. The additional visits did not appear to provide any additional information. In future, the survey teams should consider whether repeat visits are required for sites where eggs are found during the initial visit. Resource efficiencies could be made by just repeat sampling negative sites, especially those higher up in the catchment.

These recommendations were initially made in made in Garrett *et al* (2012) and Garrett *et al*. (2014).

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2013 & 2014 surveyors

Alex Harding
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Emma Keenan
Hilary Foster
Iestyn Evans
James Moon
Jill Howells
Julie Gething
Kerry Rogers
Leila Thornton
Meryl Tandy
Mike Jenkins
Nicola Broadbridge
Paul Hyatt
Richard Lewis

2015 surveyors

Keenan, E.
Baird, A
Brace, C
Rees, S
West, R
Bishop, M
Thornton, L
Hyatt, P
Tandy, M
Rees, S
West, R
Tavner, I

References

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http://data.gov.uk/dataset/wfd-surface-water-classification-status-and-objectives
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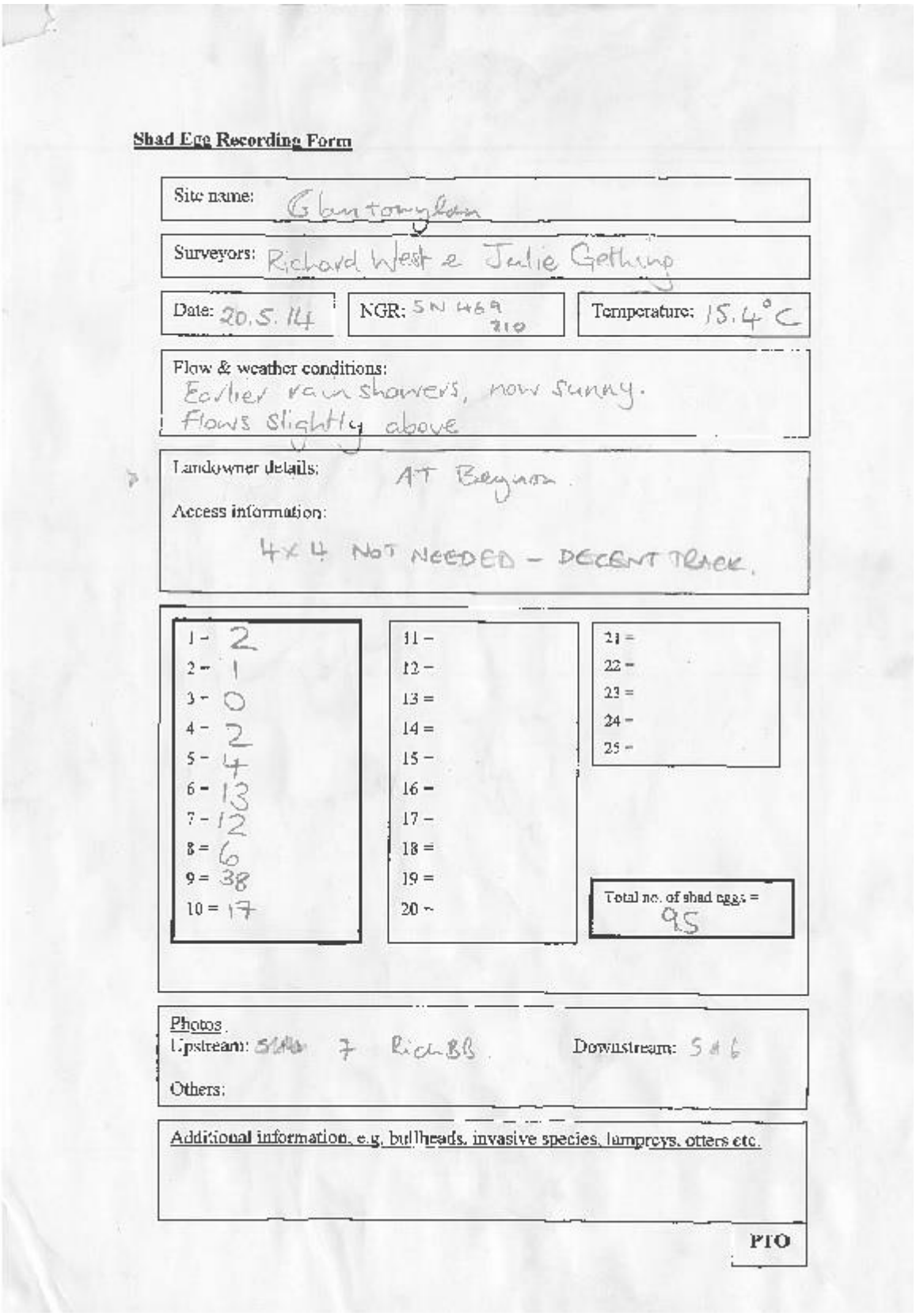
Met Office. 2015b. June 2015. [Accessed 21 July 2015]. http://www.metoffice.gov.uk/climate/uk/summaries/2015/june

Appendix 1. Example of a completed shad egg survey field record sheet.



Shad Egg Recording Form

Site name: Glantowyllan

Surveyors: Richard West & Julie Gething

Date: 20.5.14 | NGR: SN 469 210 | Temperature: 15.4°C

Flow & weather conditions:
Earlier rain showers, now sunny.
Flows slightly above

Landowner details: AT Beynon

Access information:
4x4 NOT NEEDED – DECENT TRACK.

1 – 2	11 –	21 =
2 – 1	12 –	22 =
3 – 0	13 =	23 =
4 – 2	14 =	24 =
5 – 4	15 –	25 =
6 – 13	16 =	
7 – 12	17 –	
8 = 6	18 =	
9 = 38	19 =	
10 = 17	20 =	

Total no. of shad eggs = 95

Photos
Upstream: SAM 7 RichBB Downstream: SAM 6

Others:

Additional information, e.g. bullheads, invasive species, lampreys, otters etc.

PTO

Appendix 2: Metadata archive

Data outputs associated with this project are archived as Project No. 465 and Media No. 1532 on server–based storage.

Additional metadata information is available in the Word document: Afon Tywi shad metadata archive 2015. DMS reference: SAMP-363-97